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(54) Abstract Title
Modular mobile phone apparatus

(57) A mobile phone employs interchangeable modules to enable it to operate using different communication protocols and to provide auxiliary functions such as a teletext decoder. The module may include a data interface and control circuitry, and the mobile phone itself may take the form of a PC card.

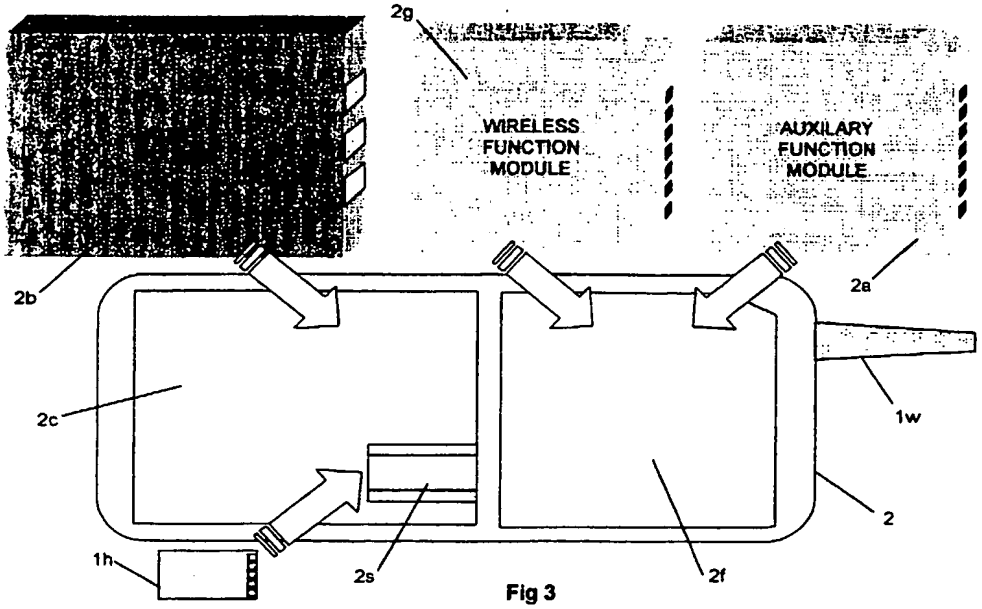

Fig 3

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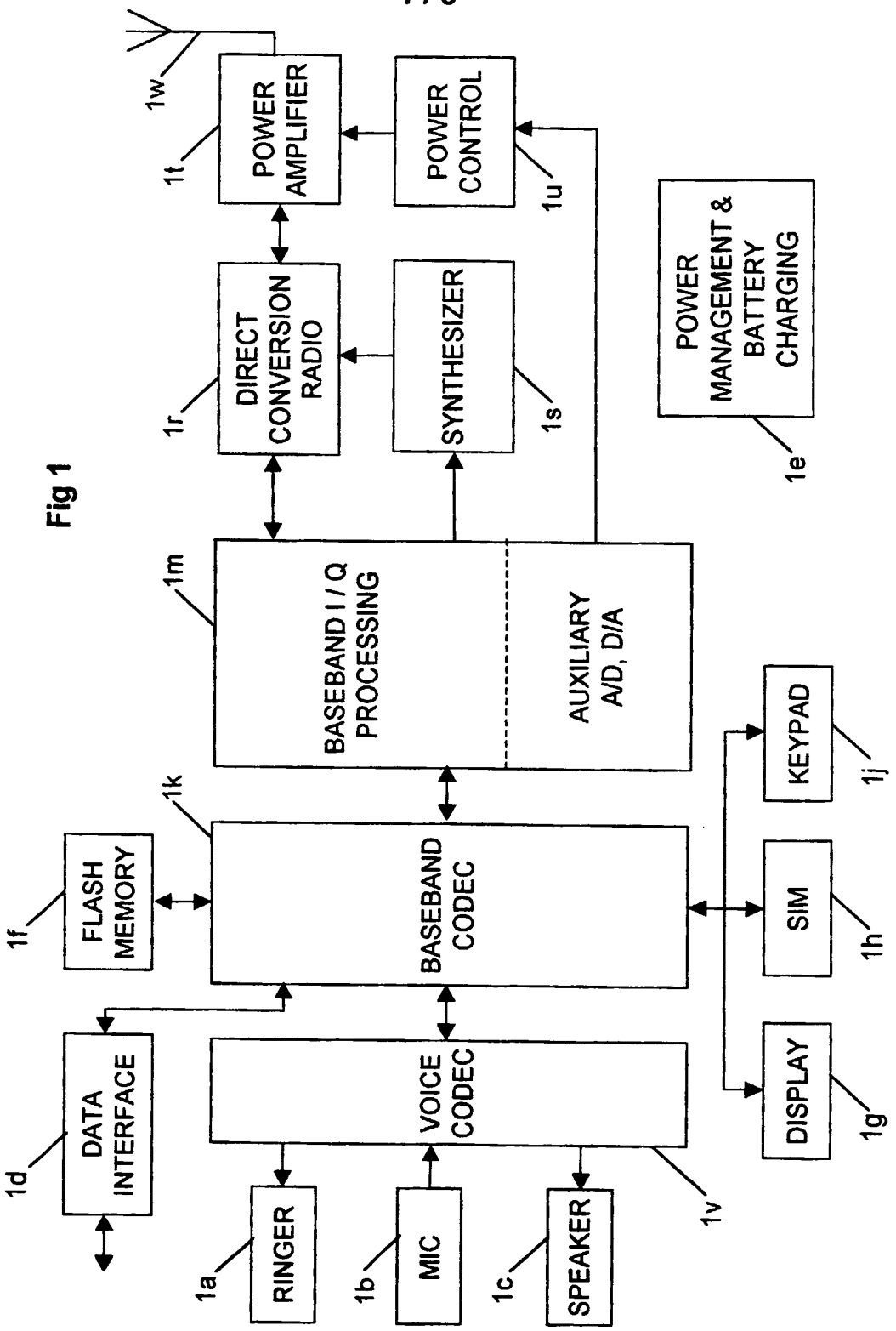
Fig 1



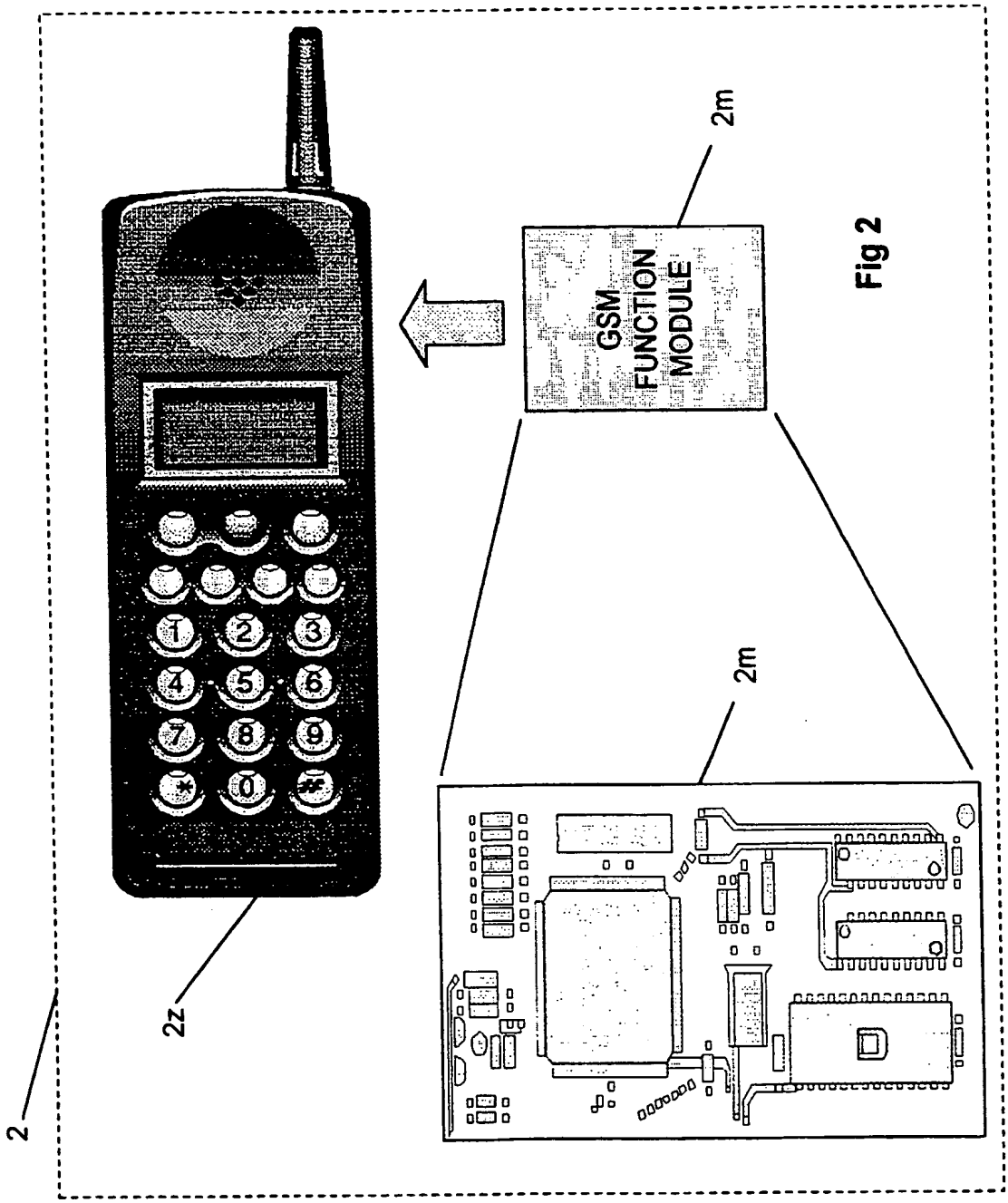


Fig 2

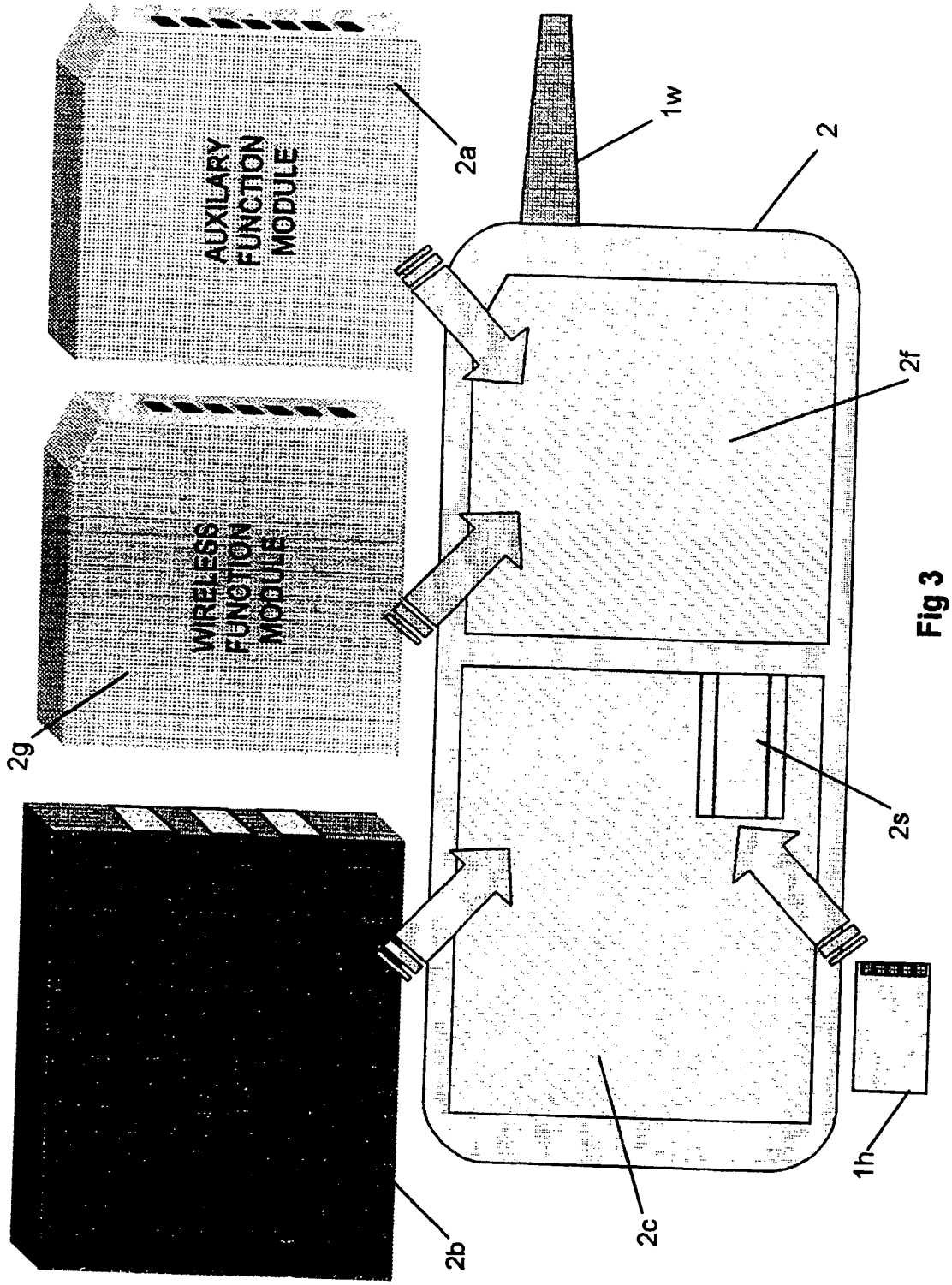


Fig 3

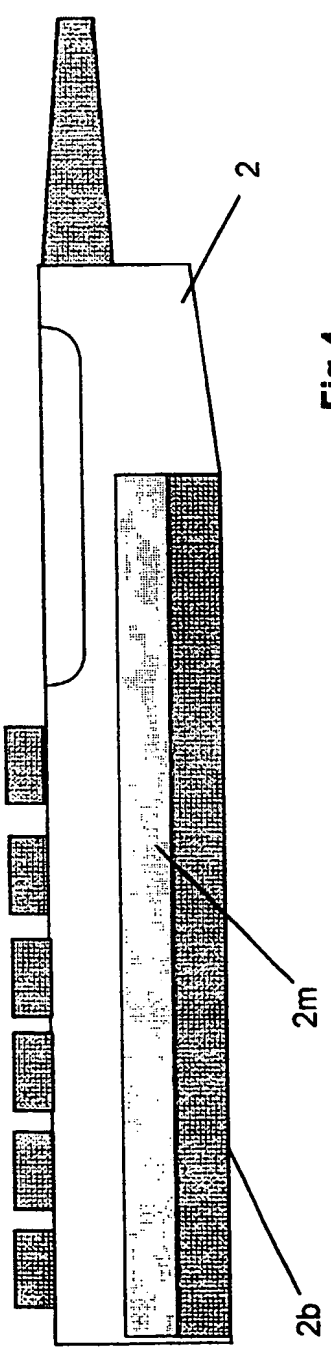


Fig 4

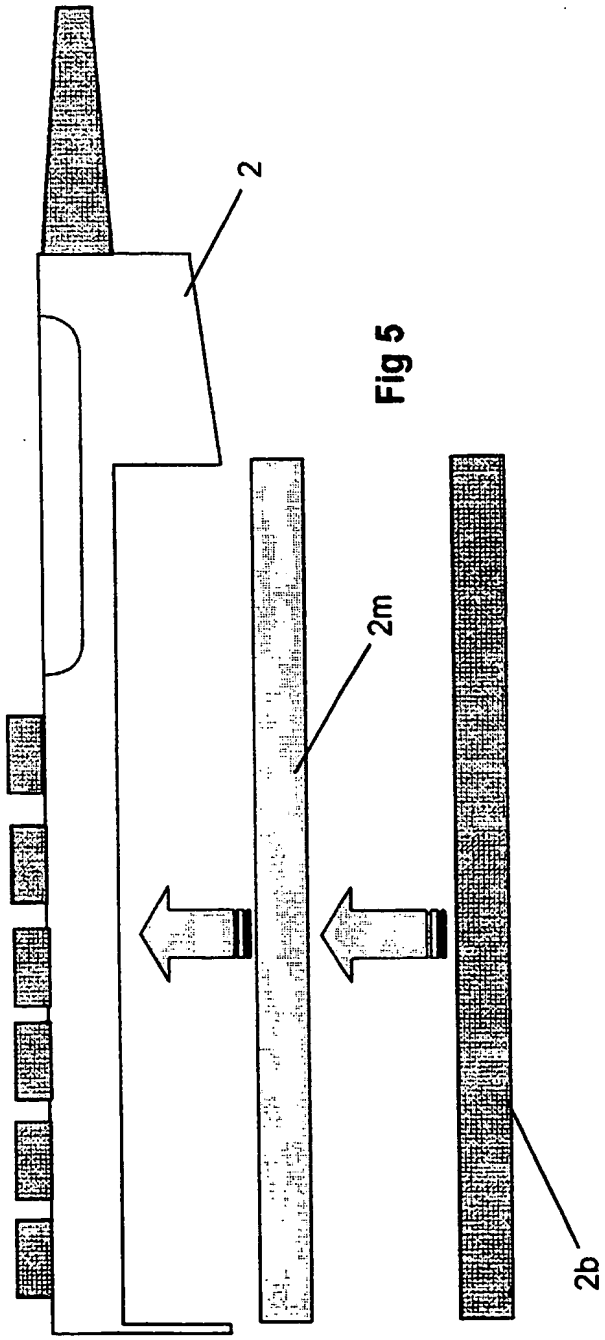


Fig 5

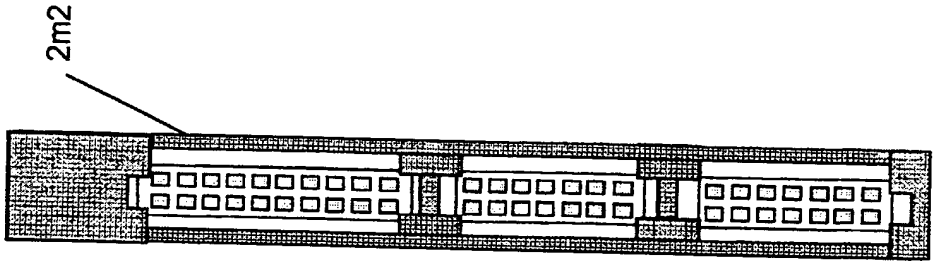


Fig 8

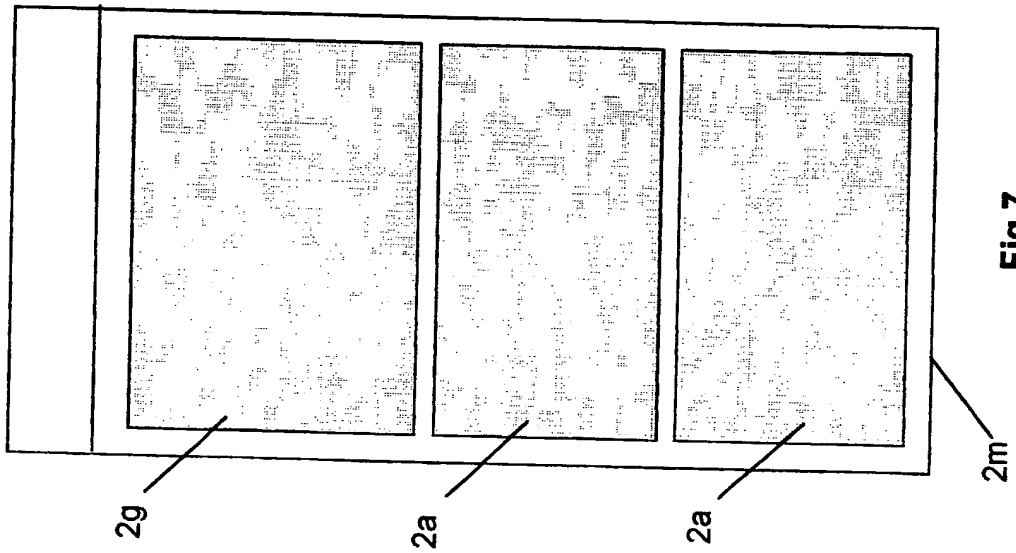


Fig 7

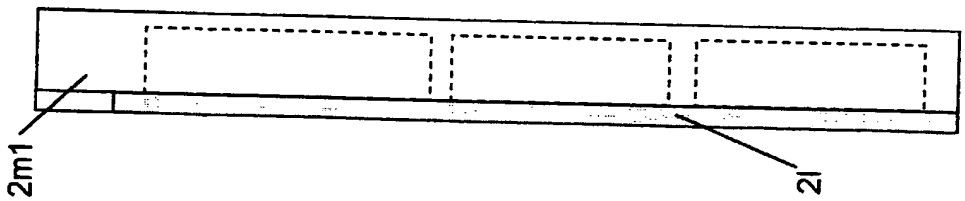


Fig 6

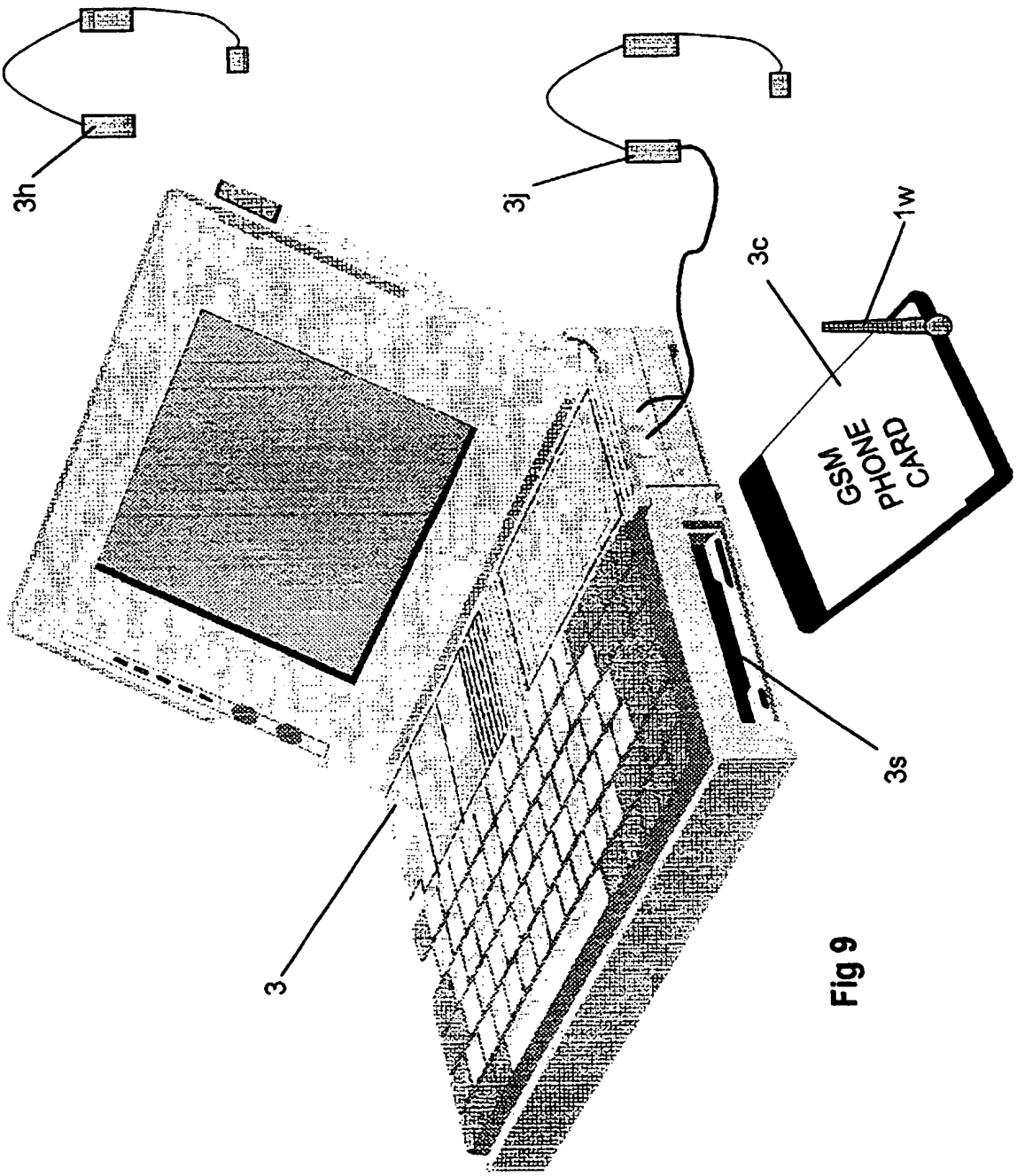
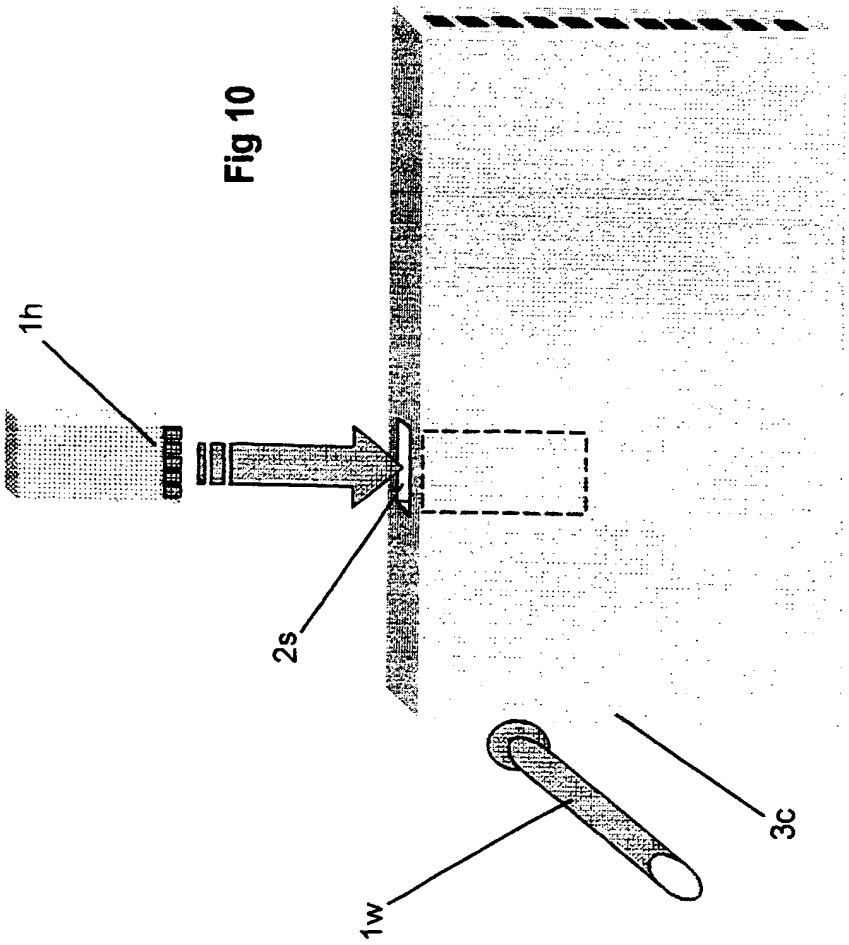


Fig 9

Fig 10



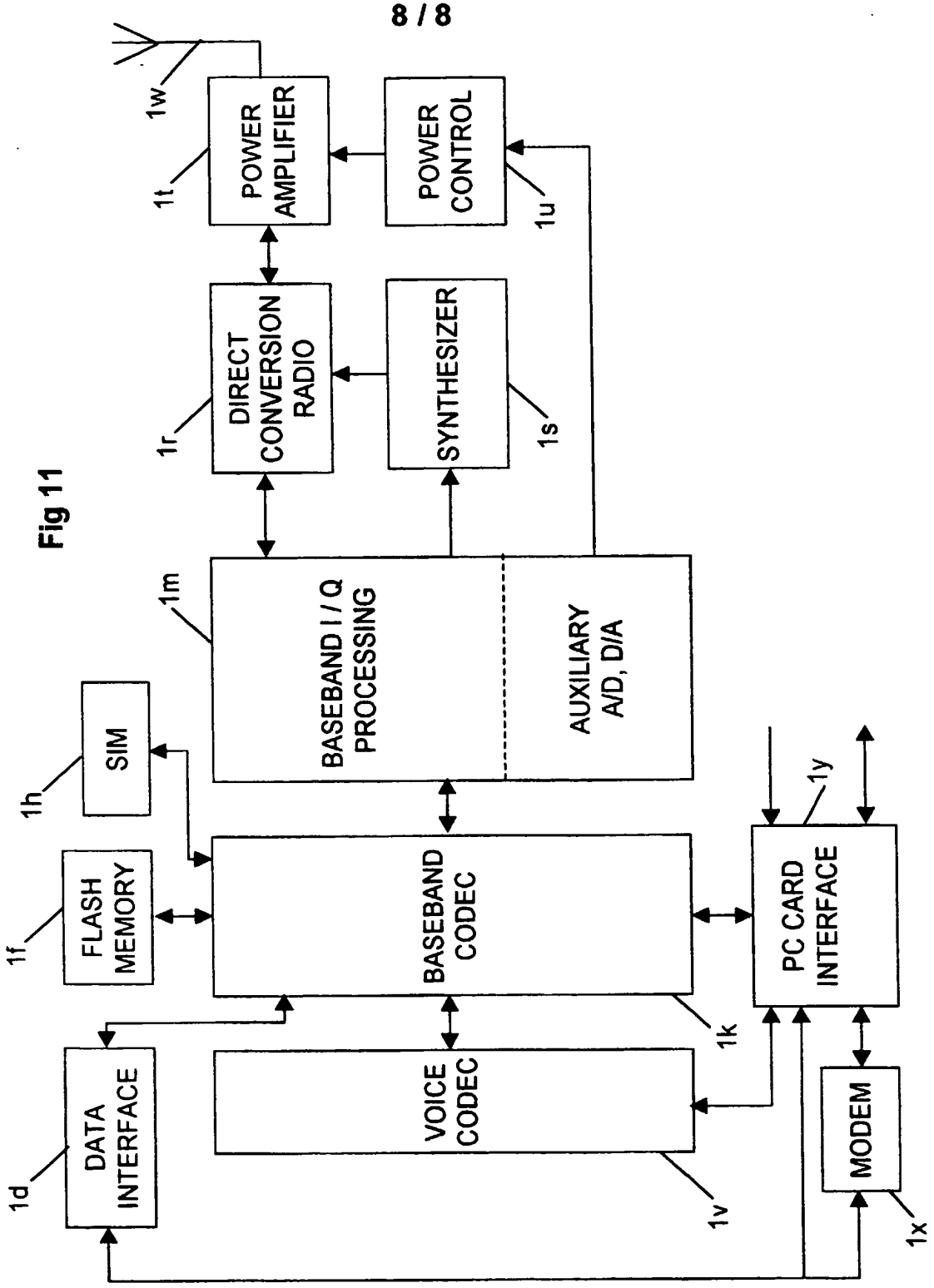

1w
1t
POWER AMPLIFIER
POWER CONTROL
1u
1r
DIRECT CONVERSION RADIO
SYNTHESIZER
1s
1m
BASEBAND I / Q PROCESSING
AUXILIARY A/D, D/A
1h
SIM
1f
FLASH MEMORY
BASEBAND CODEC
1y
PC CARD INTERFACE
1k
1d
DATA INTERFACE
VOICE CODEC
1v
MODEM
1x

Fig 11

MODULAR MOBILE / CELLULAR PHONE APPARATUS

This invention relates to a modular mobile / cellular phone apparatus.

The growth and use of mobile phones is unprecedented. More than half of the UK population own one and the recent sales of 3G licenses for more than 22 billion pounds indicates that the market is only going to get bigger. This is due to the introduction of more service and new devices to access these services.

The latest generation of mobile phones are Wireless Application Protocol (WAP) compliant, an enabling technology for transferring and presenting Internet information on hand-held and portable devices. However, current Internet access via mobile means is limited. Especially in terms of data rate speeds which for both GSM and WAP is 9.6kbps. This is because mobiles employ the SMS protocol to access and transfer Internet data. The transition from 2nd Generation (2G) mobile phones to 3rd Generation (3G) systems is under way and will be implemented in a staggered approach. Firstly, the introduction of the General Packet Radio Service (GPRS) will provide data rates of 112Kbps. Many time greater than conventional GSM phones. The second stage will be to map EDGE technology to the network providing data rates of 384kbps. Most experts believe that the introduction of GPRS later this year will be the turning point for mobile commerce as early WAP services are too slow and cumbersome to be practical.

Many experts also believe that M-commerce will prove to be the "killer application" that will drive growth in the mobile sector after the market for conventional voice calls has been saturated - a phenomenon that is likely within a few years in developed countries. E-commerce (B2B and B2C) is well established and expected to grow with greater Internet penetration. IDC predicts the figure to be 60% of the population for Western Europe by 2003.

Third generation service such as IMT2000 or Universal Mobile telephone System (UMTS) phones will eventually include satellite links for truly global roaming. The transition from second-generation (2G) phones to third generation (3G) phones will take many years to evolve and be staggered through the introduction of several key steps. It has been calculated that an initial spectrum requirement of 2 x 20 MHz per operator is needed by 2002. This will rise to 580MHz by 2010. The satellite component of UMTS will require 50MHz by 2005 and 90MHz by 2010. It is unlikely that GSM will disappear overnight and will therefore be phased out over a number of years. Therefore, many new phones will be dual or tri-band phones to operate with these different networks as they are introduced.

Already several mobile / cellular phones systems co-exist, such as TETRA, GSM and PCS. Also, some mobile phone equipment is dual or tri-band enabling the equipment to be operated with more than one mobile communication standard. The demand for higher bandwidth broadband service will require different transport mechanisms based on Asynchronous

Transfer Mode (ATM) and Internet Protocol (IP). Thus adding to the mix. The proposed HIPERLAN/2 is such an example.

However, current mobile phones will not have the circuitry to access the new networks and the ever-increasing array of new services they provide. They are effectively obsolete. They have fixed wireless circuits, which are integral to the phone and cannot be removed and easily interchanged. Anyone wishing to access the Internet via a mobile phone will need to purchase a WAP enabled phone. In the near future, these phones will also be obsolete as new and faster wireless protocols are introduced. This is expensive for customers and service providers alike, as they need to replace old mobile equipment with new equipment. It becomes expensive for network operators as they subsidize the cost of phones to customers and how they can make a profit from call / service charges. Having a modular phone, which was easily and cheaply upgradeable to new wireless standards as they are introduced, new networks and functions would be both advantageous to the customer and network operators. This architecture will also be useful to phone manufacturers who develop mobile phone apparatus for different mobile / cellular phone standards used in different parts of the world.

Much of the information available via the WAP service is also available on teletext broadcasts. Having a mobile phone with a tetletext decoder would allow a user to view information without having to make an actual phone call to the network.

Likewise, laptop computer users who wish to connect to the Internet need to connect their laptop computer to a mobile phone using a PC card modem. As new wireless standards are introduced customers will have to purchase not only a new mobile phone, but also a new PC modem card. Again, obsolescence is built in to these products. They are also cumbersome and require cables to connect them. By providing a mobile phone apparatus in a PC card format the laptop user could connect to the Internet and mobile phone services without having to use separate equipment, which needs to be connected together when the user wishes to make a call. The reduced equipment count will also reduce costs. By adopting the same modular and re-configurable architecture the PC card format the user will also be able to adapt their equipment to new wireless / mobile standards as they are introduced.

According to the present there is provided a modular and reconfigure-able mobile / cellular phone (transceiver) apparatus for transferring voice and or data and or video information which can be configured for use with existing and or future mobile / cellular wireless telecommunication protocol standards as they arise through the use of interchangeable function modules, the said apparatus comprising at least: -

a) an interchangeable wireless protocol function module which contains both digital and analogue circuitry to implement the Radio Frequency

(RF) modulation / demodulation, or direct radio conversion means, filters, synthesizer and amplifiers for one or more selected mobile telecommunication air interface (protocol) standards, baseband processing means, including I/Q channel processing means, voice coding / decoding means, associated software stacks stored in non-volatile memory means, processing means to control, monitor and manage links and interface means to connect to man-machine interface means.

A specific embodiment of the invention will now be described by way of example with reference to the following drawings in which: -

Figure 1 shows a logical block diagram of a mobile phone apparatus:

Figure 2 illustrates a modular mobile phone apparatus using an interchangeable wireless protocol module;

Figure 3 shows the rear view of a modular mobile phone apparatus with the rear cover removed and how various interchangeable modules can be connected / interfaced together to form a modular mobile phone apparatus;

Figure 4 shows another form of the modular mobile phone apparatus in which the base man-machine interface module, wireless protocol module and battery module are sandwiched together to form a modular mobile phone apparatus;

Figure 5 illustrates how the base man-machine interface module, wireless protocol module and battery module fit together to form a modular mobile phone apparatus;

Figure 6 shows a wireless protocol function module which itself has compartments for the wireless protocol function module and other auxiliary modules;

Figure 7 shows a plan view of the function module outlined in figure 6;

Figure 8 shows a wireless protocol function module which itself has side slots for the wireless protocol function module and other auxiliary modules;

Figure 9 illustrates a PC card format of the modular mobile phone for use with a portable laptop computer;

Figure 10 shows in perspective, the PC wireless phone card and interchangeable SIM module.

Figure 11 shows an example of a logical block diagram for a PC phone card.

Figure 1 outlines an example of the major circuit sub-functions required to form a GSM mobile phone apparatus. The voice codec 1v handles the various

voice coding /decoding algorithms. These include full-rate, half rate and enhanced full rate algorithms. The voice codec 1v also provides interfaces to the ringer 1a, one or microphones 1b and a speaker 1c. The voice codec 1v connects to the baseband codec 1k. This unit can take several forms, but contains the circuitry to implement the channel coding / decoding and man-machine interface functions. With today's technology it will be based on one or more processors. Management software, protocol stacks and firmware to configure the various programmable logic features is stored in the non-volatile memory 1f. FLASH memory 1f is shown in this example. The Subscriber Interface Module (SIM) card 1h interfaces to the baseband codec 1k, as does the keypad means 1j and the display means 1g. A data interface 1d performs rate adaptation and data processing for attached data equipment. The baseband codec 1k also implements Viterbi decoding, ciphering and deciphering of information.

The Direct Conversion Radio unit 1r converts received signals directly to baseband signals and in the transmit direction baseband signals to RF. No intermediate frequency processing is required in this example. Analogue to digital converters (ADCs) convert the baseband signal from the analogue domain to the digital domain in the receive direction. In the transmit direction, digital to analogue converters (DACs) convert the baseband signal from the digital to the analogue domain prior to input to the direct radio conversion circuitry 1r. The I/Q channel ADCs and DACs elements form part of the Baseband I/Q processing unit 1m.

The auxiliary analogue to digital converters (ADCs) and digital to analogue converters (DACs) shown as part of the baseband I/Q Processor 1m are used for automatic frequency control, automatic gain control and power amplifier ramp control in conjunction with the power control circuitry 1u. Aerial 1w, connected to the power amplifier 1t, is used to radiate the transmitted power and receive signals from a base station. The frequency of both the transmitted and received signals is governed by a frequency-hopping algorithm implemented in the baseband processor 1m. Synthesizer 1s generates the selected frequency.

The power supply to the various circuits is controlled by the power management circuitry 1e, which is also used to control the battery charging function.

Developments in semiconductor technology have enabled greater circuit integration and the use of mixed signal integrated chip devices, which contain both digital and analogue functions on the same device. Providing a low chip count as enabled a decrease in mobile phone size. More powerful Digital Signal Processors (DSPs) have enabled new modulation / demodulation and coding / decoding techniques to be implemented. These, together with improvements in battery technology and the use of low power silicon have seen longer stand-by and talk time and the integration of more functions. It will therefore be appreciated by those familiar with the art that Figure 1 illustrates

one form of a mobile phone and that next generation mobile phones conforming to new wireless protocols will have similar, but different circuit blocks and partitioning. For example, GSM employs a Time Division Multiple Access (TDMA) scheme whereas third generation phones may use TDMA / CDMA or Wideband – Code Division Multiple Access (W-CDMA).

Figure 2 shows a modular mobile phone apparatus 2. The wireless function module 2m is a sealed interchangeable module containing the circuitry to implement a wireless protocol and interface / connector means to interface to the mobile man-machine base unit 2.

The man-machine base unit 2z contains a keypad means 1j, display means 1g, microphone means 1b, ringer means 1a, speaker means 1c, SIM card holder 2s and interface means, a SIM card 1h, the relevant software stacks stored in non-volatile memory 1f, optional interchangeable aerial means 1w, battery charger interface means (not shown) and associated circuitry 1e and an interchangeable battery means 2b to power the circuitry in the base unit 2 and card module 2m.

The wireless function module 2m contains the circuits to implement the power amplifier 1t, direct conversion radio circuits 1r, the synthesizer 1s, power control circuits 1u, the baseband codec 1k, baseband I/Q processor and auxiliary ADCs / DACs 1m, voice codec 1v, and interface circuitry for connection the man-machine interfaces implemented in the man-machine base unit 2z. The wireless function module 2m receives its power from the man-machine base unit 2z.

A user can upgrade to a new wireless protocol and or new functions associated with a legacy protocol by removing the wireless function module 2m from the mobile man-machine base unit 2 and replacing it with a similar wireless function module 2m, which contains circuitry to implement the new wireless protocol. For example, a mobile phone user wishing to upgrade to a GPRS service, but only has a basic GSM wireless function card 2m can simply and easily swap the interchangeable wireless function module 2m for one which does implement the GPRS protocol. Or a mobile user with a GSM wireless function module 2m wishing to upgrade to a third generation wireless protocol, such as UMTS, can swap the interchangeable wireless function module 2m for one that implements the third generation wireless protocol as they are made available. Some of the logic circuitry used in the wireless function module 2m can be processor based and or based on programmable logic, such as that employed in Field Programmable Gate Arrays (FPGAs). This architecture will allow the circuits to be re-configured to implement new functions. The firmware to perform these functions being stored in the non-volatile memory 1f.

The use of standard interfaces and module dimensions would allow the wireless function modules to be used with the base units provided by several manufacturers.

As mobile phones are being used for more applications extra circuitry to implement these functions is required. Another form of the modular mobile phone apparatus is shown in figure 3. This particular version of the modular mobile phone 2 has five interchangeable modules. An interchangeable aerial 1w is provided if it is necessary to upgrade aerials when upgrading to new wireless protocols. The interchangeable SIM module 1h is held in position by the SIM holder 2S. The interchangeable battery module 2b fits in compartment 2c of the modular mobile phone apparatus 2 and is used to power both the circuitry in the base module 2 and the interchangeable function modules 2a and 2g. The interchangeable function module 2g implements the RF circuitry, baseband coding / decoding circuitry, data interfaces and voice coding / decoding for a particular wireless protocol. This is housed in a compartment 2f, which contains interface means to power and communicate with the function module 2g. Likewise, auxiliary function module 2a is a generic module, which can represent a range of functions and implements circuitry for one or more auxiliary functions. This too is housed in compartment 2f, above the function module 2a. The compartment 2f also contains interface means to power and communicate with the function module 2a. A back cover (not shown) would be used to help secure the battery 2b and function modules 2a / 2g in place. The auxiliary module 2a can contain "fixed" circuits which implement the same circuit functions or programmable logic, such as a microcontroller or Field Programmable Gate Array (FPGA) which can be reconfigured to implement new or different functions as is necessary for the required application. This extended level of programmability and re-configurability will allow a user to quickly adapt the modular and re-configurable mobile phone apparatus to new and different applications without the need to purchase new hardware. The software and firmware to implement the new circuits will be downloadable from the Internet.

In another embodiment of the invention the circuitry to implement a wireless protocol, including the baseband processing, voice / data processing, power management and RF circuitry is implemented in a module 2m. This module 2m is sandwiched between the battery module 2b and the modular man-machine base unit 2. Figure 4 shows the combined man-machine base unit 2, the wireless function module 2m and the battery module 2b. Figure 5 illustrates how the individual interchangeable modules can be separated and fixed together. The base unit 2, the wireless module 2m and the battery module 2b have interface means to allow the transfer of signals and power between the modules. Fixing means (not shown) are provided to ensure the modules connect together securely.

In yet another embodiment the wireless function module 2m itself can be expanded to accept sub-blocks or sub-modules. These sub-modules provide the circuitry to implement auxiliary functions, such as a Bluetooth wireless adapter or a videophone adapter (MPEG 4 based for example). Two forms are described. Function module 2m1 has several compartments (three shown), which provide interfaces for sub-modules. The interfaces allow

communication with the circuits of the base unit 2 and to the other sub-modules via standard interfaces. The sub-modules are held securely in position by the lid means 2l.

Function module 2m2 is a similar module, however the sub modules connect and interface to the mother module 2m2 via side slots. These sub-modules have a female connector which mates with a male connector in the function module 2m2. Figure 8 show a side view of the function module 2m2 including the side slots and internal connector means.

In a further embodiment the modular mobile phone apparatus can take the form of a PC card 3c. This arrangement will allow users of portable laptop computer 3 or other handheld computer equipment (not shown) to connector to a mobile / cellular network without the need for a separate mobile phone, PC modem card and cable. The PC phone card 3c contains the necessary circuitry to implement and communicate with a wireless mobile / cellular protocol. This includes baseband processing, voice / data processing, power management and RF circuitry. It can also include modem circuitry for data access to the Internet. Figure 11 shows an example of a logical block diagram of a PC phone card 3c with PCI interface circuitry 1y and a modem 1x. The PC phone card 3c is housed in the PC card slot 3s in the laptop computer 3.

As the PC phone card 3c doesn't have the man-machine interfaces, such as a keypad 1j, display 1g, microphone 1b, speaker 1c or ringer 1a, these can be emulated by corresponding functions (equipment) contained in the laptop computer 3. The microphone 1b and speaker 1c can be a headset unit 3h connected by cable means to the computer. Alternatively, the user headset can be a wireless headset 3j in which communication between the headset 3j and the laptop computer 3 is by wireless means. The local wireless protocol to implement this function can be based on Bluetooth, HomeRF, DECT, WATM or IEEE 802.11. The circuitry used to implement the local wireless protocol can be integrated into the PC phone card 3c or be a separate PC card or integrated in the laptop computer 3.

The interchangeable SIM module used with the PC card phone is shown in figure 10.

CLAIMS

1). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus for transferring voice and or data and or video information which can be configured for use with existing and or future mobile / cellular wireless telecommunication protocol standards as they arise through the use of interchangeable function modules, the said apparatus comprising at least: -

a) an interchangeable wireless protocol function module which contains both digital and analogue circuitry to implement the Radio Frequency (RF) modulation / demodulation, or direct radio conversion means, filters, synthesizer and amplifiers for one or more selected mobile telecommunication air interface (protocol) standards, baseband processing means, including I/Q channel processing means, voice coding / decoding means, associated software stacks stored in non-volatile memory means, processing means to control, monitor and manage links and interface means to connect to man-machine interface means.

2). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in Claim 1 wherein the said interchangeable wireless protocol function module implements either a single band, dual band or tri band of mobile / cellular wireless standards.

3). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in Claim 2 wherein the functionality of the wireless protocol function module is implemented using more than one interchangeable module.

4). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in any preceding claim wherein the wireless protocol function module has a data interface and control circuitry for handling transmitted and received data streams.

5). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in any preceding claim wherein the said phone apparatus comprises

a) a handheld base unit itself comprising the keypad means to enter alpha-numeric characters, display means to display input information and received information, a fixed or interchangeable aerial means, microphone means, speaker means, ringer means, a SIM card holder and SIM card, battery charger interface and circuits to control battery charging, a battery compartment to house a rechargeable battery and a slot or compartment together with appropriate interfaces to allow the insertion / extraction of the said interchangeable wireless protocol function module,

b) the said interchangeable wireless protocol function module,

c) rechargeable battery means.

6). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in Claim 4 wherein the said phone apparatus comprises

a) a handheld base unit itself comprising the keypad means to enter alpha-numeric characters, display means to display input information and received information, a fixed or interchangeable aerial means, microphone means, speaker means, ringer means, a SIM card holder and SIM card, battery charger interface and circuits to control battery charging, a battery compartment to house a rechargeable battery and a compartment together with appropriate interfaces to allow the insertion / extraction of the said interchangeable wireless protocol function module and an auxiliary function module,

b) the said interchangeable wireless protocol function module,

c) the said interchangeable auxiliary function module,

d) rechargeable battery means,

e) detachable cover means to cover and securely hold the said battery means and function module means in place.

7). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in Claim 4 wherein the said phone apparatus comprises

a) a handheld base unit itself comprising the keypad means to enter alpha-numeric characters, display means to display input information and received information, a fixed or interchangeable aerial means, microphone means, speaker means, ringer means, a SIM card holder and SIM card, battery charger interface and circuits to control battery charging, a cut away section a the rear of the unit with connection means to house and securely hold an interchangeable wireless protocol function module and rechargeable battery means, the interchangeable wireless protocol function module being sandwiched between the handheld base unit and the rechargeable battery means,

b) the said interchangeable wireless protocol function module,

c) rechargeable battery means.

8). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in Claim 7 wherein the interchangeable wireless protocol function module contains compartments and interfaces for sub-modules, the interfaces allow communication with the circuits of the handheld base unit and to the other sub-modules via standard interfaces, the sub-modules performing auxiliary application functions as well as the wireless protocol functions, the sub-modules being held securely in position by the lid means.

9). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in Claim 7 wherein the interchangeable wireless protocol function module contains side slots and interfaces for sub-modules, the interfaces allow communication with the circuits of the handheld base unit and to the other sub-modules via standard interfaces, the sub-modules performing auxiliary application functions as well as the wireless protocol functions

10). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in Claim 4 wherein the said apparatus takes the form of a PC card which is inserted into the PC card slot of a laptop or handheld computer device, the PC card containing both digital and analogue circuitry to implement the Radio Frequency (RF) modulation / demodulation, or direct radio conversion means, filters, synthesizer and amplifiers for one or more selected mobile telecommunication air interface (protocol) standards, baseband processing means, including I/Q channel processing means, voice coding / decoding means, SIM card and holder means, associated software stacks stored in non-volatile memory means, processing means to control, monitor and manage links and interface means to connect to man-machine interface means and system bus means contained in the laptop or handheld computer device means.

11) A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in Claim 10 wherein the man-machine interfaces are the display means, the keypad means, the microphone means, ringer means and speaker means are those provided by the computer means.

12). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in Claim 10 wherein the microphone means and speaker means are provided by a headset connected to the computer means by cable means.

13). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in Claim 10 wherein the microphone means and speaker means are provided by a wireless headset connected to the computer means by wireless means.

14). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in preceding claim wherein the auxiliary function module implements a teletext decoder allowing the user to view broadcast teletext information on the said mobile phone means.

15). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in preceding claim wherein programmable and or re-configurable logic is used to implement some or all of the circuits used in the said wireless protocol function module and or the said auxiliary function modules.

16). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in any preceding claim wherein plug and play means are employed so the host processor in the wireless protocol function module can read the status of other modules and interfaces and configure the said apparatus accordingly.

17). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus as claimed in any preceding claim wherein the function modules employ hot swappable circuitry to allow then to be interchanged while in use.

18). A modular and reconfigure-able mobile / cellular phone (transceiver) apparatus substantially as described herein with reference to Figures 1 – 11 of the accompanying drawings.

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Application No: GB 0020764.7 12 **Examiner:** Glyn Hughes
Claims searched: 1 to 18 **Date of search:** 2 May 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): H4L (LEP, LESF), H4K (JK)

Int Cl (Ed.7): H04Q 7/32

Other: Online: WPI, EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2345988 A	(PHILLIPPS) see abstract	-
X	GB 2329303 A	(MOTOROLA) see page 4 lines 4 to 19	1-3, 5
X	GB 2319438 A	(IMSO) see abstract	1-3, 5
X	GB 2292653 A	(MOTOROLA) see abstract	1-3, 5
A	JP 10063808 A	(YAMAHA) see WPI abstract	10

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.